HARBOR SEAL POPULATION TRENDS AND FACTORS INFLUENCING COUNTS AT NANVAK BAY, NORTHERN BRISTOL BAY, ALASKA

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INTRODUCTION

Population trends of harbor seals (*Phoca vitulina richardsi*) in Alaska vary regionally. In southern and north central Southeast Alaska, populations have been stable or increasing since the early 1980s (Small *et al.* 2001). Harbor seal numbers in Glacier Bay (northern Southeast Alaska) declined 25 – 48% from 1992 – 1998 (Mathews and Pendleton 2000), and counts of seals at terrestrial sites in Prince William Sound have declined 63% from 1984 – 1997 (Frost *et al.* 1999). Biennial counts conducted at Tugidak Island (south of Kodiak Island) in the western Gulf of Alaska declined 72% - 85% from 1976 through 1988 (Pitcher 1990). The harbor seal population on Tugidak Island stabilized in the early to mid 1990s and has been increasing in recent years (Jemison and Pendleton 2001).

Population data on harbor seals in the Bering Sea have been collected sporadically since the 1960s. Daily counts of harbor seals on Otter Island, the largest haulout in the Pribilof Islands, were conducted during the summers of 1974, 1978[1], and 1995 (Johnson 1976, L. Jemison unpublished data). Systematic counts of seals in the Aleutian Islands were first conducted in 1994 and this region was surveyed again in 1999 (Withrow and Loughlin 1995, Withrow *et al.* 2000). Most survey efforts in the Bering Sea have focused on the large concentrations of seals that haul out along the north shore of the Alaska Peninsula in southern Bristol Bay (Everitt and Braham 1980, Pitcher 1986, Loughlin 1992, Withrow and Loughlin 1996, Small 2001). Aerial counts of seals along the Alaska Peninsula were conducted during the pupping and/or molting periods in 1966 – 1977 (excluding 1967, 1972, 1974, and 1976), 1985, 1990, 1991, 1995, and 1998 - 2000. These counts suggest a reduction in seal abundance between the 1970s and 1990s, but no estimate of population trend during the 1990s is available (Everitt and Braham 1980, Pitcher 1986, Loughlin 1992, Withrow and Loughlin 1996, Small 2001). Aerial counts of seals along the northern Bristol Bay coast were made in 1991 and 1995 (Loughlin 1992, Withrow and Loughlin 1996) and parts of this region were surveyed in 1975 (Everitt and Braham 1980).

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[1] Personal communication from Brendan P. Kelly, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 11120 Glacier Highway, Juneau, Alaska 99801, April 2000.

In Alaska, detailed monitoring data (*e.g.*, daily counts of all seals and of pups during the pupping and molting periods) on harbor seals are collected at three land-based 'index' sites: Nanvak Bay, Tugidak Island, and Johns Hopkins Inlet in Glacier Bay. Although counts of seals at these index sites do not provide an estimate of total population abundance, they have been used to estimate population trend and as indices of local and regional seal abundance (Pitcher 1990, Udevitz 1999). However, estimates of population trend and abundance from raw counts (not adjusted for effects of environmental and other covariates) are biased, because the proportion of seals in the population available to be counted is not constant. Additional information recorded at index sites on 'covariates' (*e.g.*, date, time of day, tidal stage) should be incorporated into statistical analyses to account for variation in the proportion of the seal population ashore when counts are conducted (Frost *et al.* 1999, Mathews and Pendleton 2000, Jemison and Pendleton 2001, Small *et al.* 2001). Subsequently, knowledge of the effects of covariates on the proportion available to be counted can be used to improve the experimental design, data collection, and statistical analyses of spatially extensive population surveys (*e.g.*, aerial surveys of multiple sites) resulting in more accurate and precise estimates of population trend and abundance (Adkison *et al.* 2001).

The only site in the Bering Sea where harbor seals were monitored on a daily basis for a certain period each year during the 1990s was Nanvak Bay, the largest haulout in northern Bristol Bay. Land-based counts at this site were conducted during the pupping and molting periods from 1990 – 2000. Taking into account the effects of covariates, we estimate population trends for both the pupping and molting periods during 1990-2000. We examine the effects of covariates on the counts of seals on shore and compare the estimated effects with other studies. In addition, we document dates of maximum counts during pupping and molting and discuss the value of detailed data collected from index sites.

METHODS

Study area---Nanvak Bay (58°35′N 161°45′W), a shallow bay that supports extensive eel grass (*Zostera marina*) beds, is situated 25 km southeast of Cape Newenham, the point that divides Bristol and Kuskokwim bays (Fig. 1). Harbor seals, and possibly spotted seals (*Phoca largha*), haul out on sandbars, mudflats, and a barrier spit near the mouth of the bay. The sandbars and mudflats (Mid Bay Bars) are submerged at high tide but the haulout site on the barrier spit is exposed during all but extreme high tides. Although the bay is shallow, all haulouts are adjacent to a deep-water channel, allowing direct access to the bay and the outer coast.

Data collection---We used spotting scopes (20x - 60x) and binoculars (10 x 42) to conduct daily counts of harbor seals from mid May through September or October in 1990 – 2000. In 2000, additional counts were collected during 15 days centered around both the peak pupping and molting periods. During those periods, seals were counted every 3-5 hours between 06:00 and 21:00. We identified the pupping and molting periods based on visual observations of seal behavior and pelage condition. On most days, we counted seals from either of two observation points, North Spit Dune (NSD) or Watch Point Dune (WPD). NSD provided a closer and better view of seals hauled out on the mudflats and was our preferred observation point; to access NSD we used a kayak to cross Nanvak channel. At our secondary observation site, WPD, a 4m tower atop the dune provided extra elevation to view seals. WPD was used when rough water made channel crossing risky or when seals were present on the barrier spit. We counted the total number of seals on shore, documented dates of maximum counts, and recorded weather conditions (wind speed, wind direction, precipitation, cloud cover, and air temperature).

Tides in Nanvak Bay do not follow predicted cycles in published tide tables. High tides during daylight hours almost always occurred in the morning. Counts were usually conducted in the afternoon or evening, when the one obvious daily low tide regularly occurred, except in 2000 when additional counts were made throughout the day. We recorded tidal stage as a categorical variable (high, low, rising, falling) based on direct observations during each count.

Analyses---We analyzed counts from 8 June to 10 July during the pupping period and from 1 August to 15 September during the molting period and estimated the trend in harbor seal abundance during both periods. Multiple counts were made on some days; all counts were included in the analyses. We did not include counts conducted in 1999 in our analyses due to inconsistencies in data collection. When estimating trends, we evaluated the influence of the following covariates: date, time relative to midday (solar noon), tidal stage, count quality (high, moderate, low; based on seal haulout location and the observation platform), and weather covariates: cloud cover (none, partial, complete), precipitation (present, absent), air temperature (^{0}C), wind speed (mph), and wind direction. We allowed wind speed to vary by wind direction (*i.e.*, wind speed*wind direction interaction). We evaluated quadratic terms for the covariates date, time of day, and wind speed (by direction). We also included a quadratic year effect in the initial model.

We were able to adjust for annual changes in the date of the peak count during both pupping and molting, since we had long series of counts within all years to determine the date of peak abundance. This allowed us to better estimate trend and the effects of other covariates. Within each year, we subtracted the date of the maximum count from each date to center the data. In the subsequent analyses, the date covariate represents the decrease in counts relative to the within-year peak.

We estimated trends and adjusted for covariates using mixed generalized linear models (Poisson errors and log link) (Littell *et al.* 1996). We accounted for autocorrelation among counts within years by using a spatial correlation structure with distance based on the time elapsed between counts (Littell *et al.* 1996). When final models did not fit the Poisson assumptions, we used quasilikelihood methods (McCullagh and Nelder 1989) to inflate the estimated standard errors. We began with the full model including all of the covariates and quadratic terms and eliminated terms from the model one at a time based on the Wald test statistics (P>0.05). We also used a small sample version of Akaike's Information Criteria (AICc) to help assess which variables to retain in the final model (Hurvich and Tsai 1989). In order to estimate trend, the year effect was retained in all models regardless of the Wald statistic. To evaluate the relative effect of the covariates on the final trend estimate, we omitted individual covariates and estimated the trend using the remaining covariates that were significant in the final model. We then calculated the percent change in trend by comparing the model with the covariate omitted to the full model.

RESULTS

Trends---For the 11-year period from 1990 – 2000, land-based counts of harbor seals at Nanvak Bay increased significantly during the pupping period (9.2%/yr) and during the molting period (2.1%/yr) (Table 1, Fig. 2).

Covariates---Date^2, time relative to midday, tidal stage, and count quality were significant covariates in both the pupping and molting period trend estimates, and precipitation and wind speed were additionally important during the molting period (Tables 1 - 3). The substantial influence of the covariates can be seen when trends are estimated with and without inclusion of the covariates. The pupping period trend, estimated without covariates, was 5.5%/yr, a –40.7% change from the final covariate model estimate (Table 2). During the molting period, the estimated trend without covariates in the model was 0.7%/yr, a change of –66.3% from the final covariate model. Trend estimates were most sensitive to tidal stage and count quality during the pupping period, and time to midday and precipitation during the molting period, as the largest percent change in trend estimates was observed when these covariates were individually omitted.

The highest counts of seals generally occurred between midday (solar noon) and 6 hours after midday (approximately 14:50 – 20:50 hours) (Fig. 3). Counts were negatively related to high and rising tides during molting and negatively related to high tides during pupping (Table 3). High-quality counts were 33% - 39% higher than moderate-quality, and were 30% - 40% higher than low-quality counts during both periods. Pupping period counts were unaffected by weather variables. Counts during the molting period, however, were negatively related to both precipitation and wind speed (Table 3, Fig. 4). Cloud cover, air temperature, and wind direction were not significant in either analysis.

Maximum counts---In general, the number of seals counted at Nanvak Bay is relatively constant from late May through early July; only in some years is there a small peak during the pupping period. In mid to late July, numbers increase and remain elevated through August and into early September, before declining (Fig. 5). The dates of maximum counts during pupping ranged from 12 June to 8 July. During molting, dates of maximum counts ranged from 13 August to 3 September (Fig. 6).

DISCUSSION

In the Bering Sea, harbor seals haul out on the rocky shores of the Aleutian and Pribilof islands, along the sand beaches and barrier spits of the Alaska Peninsula, and on the sand and rock beaches and islands of the northern Bristol Bay coast. Population data on harbor seals in this region are limited. Nanvak Bay is the only site in the Bering Sea where harbor seals were monitored annually during the past decade. From 1990 – 2000, the number of seals on shore increased 9.2%/yr during the pupping period and 2.1%/yr during the molting period. In 1975, the only other year when standardized counts were conducted, maximum counts during pupping and molting were 375 and 2942, respectively (Johnson 1976). When we began monitoring seals in the early 1990s, maximum counts at Nanvak Bay were 2-3 times lower during the pupping period and 6 times lower during the molting period than in 1975. By 2000, however, the maximum count during pupping (477) was greater than in 1975, whereas the maximum count during molting (575) was still 5 times lower.

Accurate counts of pups at Nanvak Bay requires that experienced observers conduct frequent counts of pups from the NSD observation point during the peak pupping period. As a result, we do not have consistent and reliable pup counts from all years. Based on the reliable data that is available (*e.g.,* an experienced observer counted pups from NSD on at least 10 days between 18 June and 7 July), pup counts appear to follow the same trend as all seals counted during the pupping period from 1990 – 2000; *i.e.*, ~9% increase annually. For example, maximum pup counts were 21 (1991), 24 (1992), and 47 (2000). The maximum pup count in 2000 was greater than the maximum count in 1975 (36) (L. Jemison unpublished data, Johnson 1976). The cause of the discrepancy between pupping and molting period trends is unknown. It is possible that seals ashore during the pupping period may be more representative of the resident population than seals hauling out later in the summer. In 1975, Johnson (1976) observed a steady increase in the number of seals at Nanvak Bay throughout the summer.

Nanvak Bay is usually ice covered from about November until late April or May, restricting access to haulout sites. Harbor seals in Kuskokwim Bay may move south in front of the advancing ice pack in fall and haul out at Nanvak Bay while en route to waters that remain ice-free in the winter. Additionally, there have been reports of spotted seals at Nanvak Bay[2] (Johnson 1976). Although we do not currently have evidence to confirm or deny these reports, genetic analyses of tissue samples collected from seals at Nanvak Bay in 2000 are being processed, and information on species present should be available in 2001[3]. Because of the potential presence of spotted seals at Nanvak Bay, and possible fluctuations in their numbers and use of Nanvak Bay haulouts, caution is needed in interpreting our population trend data in regards to harbor seals.

Populations of harbor seals in the northeastern Pacific have fluctuated during historic times and have been subject to a variety of natural and anthropogenic influences (*e.g.*, Fisher 1952, Lensink 1958, Olesiuk *et al.* 1990, Pitcher 1990). Bounties and predator control programs designed to reduce seal predation on salmon, and commercial harvests for pelts resulted in periodically high levels of harbor seal harassment and killing along the western coast of North America from the early 1900s through the early 1970s (Fisher 1952, Lensink 1958, Newby 1973, Stewart *et al.* 1988, Paige 1993). Protection was afforded harbor seals in 1972 in the United States via passage of the Marine Mammal Protection Act. An estimated 3,000 seals, mostly pups, were harvested annually for their pelts along the Alaska Peninsula between 1963 and 1972, accounting for about 50% of the pup production (Pitcher 1986). Whether seals were killed for bounty or commercial sale at Nanvak Bay is not known, nor is the impact of bounty kills and commercial harvests on the Bering Sea harbor seal population.

Along much of the west coast of North America, the end of exploitation led, in part, to population increases (Jefferies 1986, Boveng 1988, Harvey *et al.* 1990, Olesiuk *et al.* 1990). Although a population increase following release from harvest pressure would have been expected along the Alaska Peninsula, aerial counts of seals in this region suggest that numbers declined between the 1970s and 1990s (Pitcher 1986, Loughlin 1992, Withrow and Loughlin 1996). Based on daily pupping period counts of harbor seals at Otter Island in the Pribilof Islands, maximum counts of all seals declined 40% (from 1175 to 707) and maximum counts of pups declined 50% (from 228 to 114) between 1974 and 1978[4] (Johnson 1976). Given Otter Island's remote location and the difficulty of accessing the island, it is unlikely that human activity at that haulout played a role in the large reduction in seal numbers in that four year period. Between 1978 and 1995, further declines in all seals (71%; from 707 to 202) and in pups (63%; from 114 to 28) were documented (L. Jemison unpublished data). Fur seals (*Callorhinus ursinus*) began to haul out on Otter Island in the early 1980s (Hansen 1982), and may have since had a negative impact on the harbor seal population. By 1995, more than 1,000 fur seals were ashore on most days in July, and there was evidence suggesting that several harbor seal pups were trampled to death by fur seals (L. Jemison,

[2] Personal communication from John J. Burns, Living Resources Inc., Fairbanks, Alaska, May 1990.
[3] Personal communication from Dave E. Withrow, National Marine Fisheries Service, National Marine Mammal Lab, 7600 Sand Point Way NE, Seattle, WA 98115, September 2000.
[4] Unpublished data provided by Brendan P. Kelly, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 11120 Glacier Highway, Juneau, Alaska 99801, April 2000.

unpublished data). In the central and western Gulf of Alaska, the harbor seal population declined dramatically during the late 1970s and 1980s at Tugidak Island and in Prince William Sound (Pitcher 1990, Frost *et al.* 1999). At Tugidak Island, the population stabilized during the early to mid 1990s and is now increasing, although the population remains greatly reduced from the 1970s (Jemison and Pendleton 2001).

Harbor seal populations southeast of the Gulf of Alaska along the shores of North America have shown a different pattern in recent decades. These populations did not undergo large declines in the 1970s and 1980s, but have generally increased over this period. Specifically, in southern Southeast Alaska, the harbor seal population increased an estimated 7.4% annually from 1983 - 1998, similar to increases in British Columbia (12.5%/year from 1973 – 1988), Washington (7% – 30% from 1977 – 1984), Oregon (about 8%/year from 1975 – 1983) and California (15% from 1965 – 1986) (Jefferies 1986, Boveng 1988, Harvey *et al.* 1990, Olesiuk *et al.* 1990, Small *et al.* 2001). However, these increases have not been uniform across the entire coast. Population trends in north-central Southeast Alaska were 1.1%/yr from 1984 through 1999, indicating stability (Small *et al.* 2001) and declines have been documented in Glacier Bay at both terrestrial and glacial ice haulouts during the 1990s (Mathews and Pendleton 2000).

Concurrent with the patterns of change observed in harbor seal populations in the northeastern Pacific, similar population changes have been documented for Steller sea lions (*Eumetopias jubatus*) in Alaska, with populations declining in the western Gulf of Alaska and the Bering Sea (Merrick *et al.* 1987, Loughlin *et al.* 1992), but stable or increasing numbers in Southeast Alaska (Calkins *et al.* 1999), suggesting these parallel trends may be influenced by some larger oceanic effect. The cause of marine mammal declines in the Gulf of Alaska and Bering Sea, but increasing trends in adjacent areas remains unclear. A leading hypothesis points to changes in prey abundance and/or availability playing a role (*e.g.*, Merrick *et al.* 1987, Trites 1992, Merrick *et al.* 1997, Calkins *et al.* 1998, Pitcher *et al.* 1998, Jemison and Kelly 2001).

Covariate effects---In addition to changes in seal numbers, other factors influence the number of seals on shore. Seasonal fluctuations in seal abundance associated with pupping and molting are well documented (*e.g.,* Stewart and Yochem 1984, Allen *et al.* 1988, Grellier *et al.* 1996). On a finer scale, other variables can affect the number of seals hauled out. At Nanvak Bay, the covariates that affected counts of seals during both pupping and molting periods were date, time relative to midday, tidal stage, and count quality. The covariates time relative to midday and tidal stage could be confounded, as high tides during daylight hours almost always occurred in the morning, and low tides occurred in the afternoon and evening. Haulout space is limited during high tides as all haulouts are submerged except the barrier spit. The negative relationship between high tide and counts of seals is greater during pupping (-67%) than during molting (-37%), probably because seals do not haul out on the barrier spit during the pupping season.

The greatest number of seals on shore generally occurred from about midday to 6 hours after midday (approximately 14:50 – 20:50 hours ADT). Studies of harbor seals in other areas have identified time of day as an important factor related to counts of seals (Stewart 1984, Pauli and Terhune 1987, Thompson *et al.* 1989, Kovacs *et al.* 1990), but the relationship is not consistent among areas. In studies where haulout substrate is available only at low or moderate tides, maximum counts of seals are more frequently reported during afternoon low tides (Allen *et al.* 1984, Pauli and Terhune 1987, Thompson *et al.* 1989, Kovacs *et al.* 1990, Watts 1996), though some maximum counts have been reported during morning low tides (Olesiuk *et al.* 1990, Frost *et al.* 1999). At sites where haulout space is available during all tidal stages, diurnal patterns tend to dominate over tidal cycles with seal numbers peaking in the afternoon (Stewart 1984, Godsell 1988, Jemison and Pendleton 2001). These differences in haulout patterns highlight the importance of evaluating covariate effects among haulout sites and regions when surveying multiple sites.

The dates of maximum counts during the molting periods ranged from 13 August to 3 September. In 1975, the date of the peak count occurred on 31 August (Johnson 1976). The wide range in dates of peak counts was much greater than what was observed at Tugidak Island, where peak counts during molting occurred from 2 – 8 August from 1997 – 2000 (Jemison and Pendleton 2001, L. Jemison unpublished data). We believe that our estimates of the date of maximum counts is biased by our inability to collect daily counts from the optimal observation point (NSD), often due to rough water conditions. There was no obvious pattern of peak molting period counts moving progressively earlier or later from 1990 – 2000 (Fig. 6). Dates of maximum counts during the pupping period ranged from 12 June to 8 July, with some indication that peak counts may be earlier in recent years. In 2000, counts during the pupping period did not begin until 20 June, later than usual; the maximum number hauled out might have occurred prior to that date.

We also investigated the effect of weather variables including precipitation, cloud cover, wind speed, wind direction, and temperature. In general, counts during the pupping period were unaffected by weather variables. During the molting period, counts were reduced when winds were high (>30mph). There was a relatively weak negative relationship between counts and precipitation during the molting period, although we might have found a stronger relationship if our precipitation category had distinguished between mist/light rain and heavy rain. At Tugidak Island, Jemison and Pendleton (2001) found counts conducted during mist/light rain were similar to those when there was no precipitation; however, heavy rain caused substantial declines in the number of seals hauled out. We ranked counts according to count quality and included this variable in the model. We found that high quality counts were about 30% to 40% higher than both moderate and low quality counts and that there was little difference between moderate and low quality counts. In the future, greater effort should be placed on obtaining high quality counts at Nanvak Bay, although the covariate model does allow us to use lower quality counts when better counts are not available.

In Alaska, only three long-term, land-based monitoring sites exist where detailed data on harbor seals are being collected. Data from these sites can be used to estimate trends in seal numbers over time, and enhance our understanding of factors that influence the number of seals on shore, the timing of life history events and temporal shifts in those events, and regional differences in haulout patterns. Additionally, data from these sites can contribute to determining the best time to conduct population surveys, such as optimal time of day or date.

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Table 1. Annual trend estimates for harbor seals at Nanvak Bay, Alaska, during the pupping and molting periods from 1990 – 2000 (excluding 1999), and covariates that significantly ($P<0.05$) influenced the number of seals hauled out. A '+' indicates a positive relationship between count and covariate, a '-' indicates a negative relationship, and a '*' indicates significance for categorical covariates.

Season	Trend (%/yr)	95% CI	Covariates							
			Date^2	Time to midday	Time to midday^2	Tidal stage	Count quality	Precip-itation	Wind speed	Wind speed^2
Pupping Period	9.2%	7.2% to 11.3%	-	+	-	*	*			
Molting Period	2.1%	0.6% to 3.6%	-	+	-	*	*	*	-	-

Table 2. Harbor seal trend estimates during the pupping and molting periods with the omission of individual covariates, Nanvak Bay, Alaska, 1990-2000 (excluding 1999).

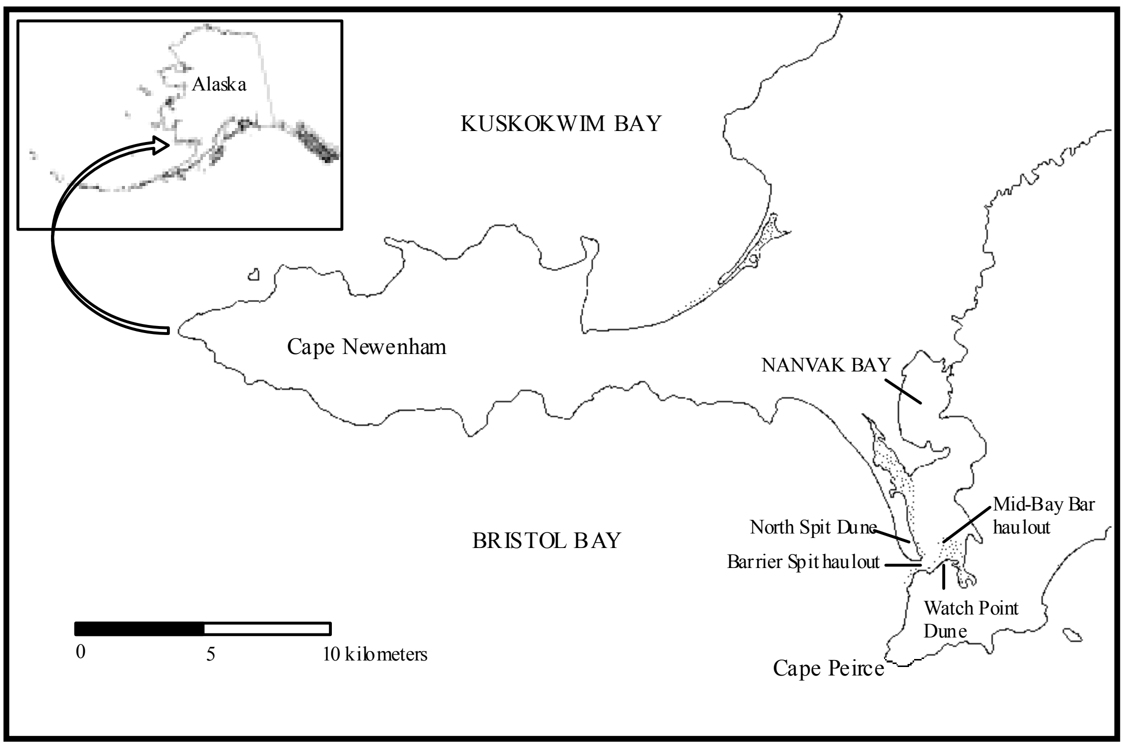
Covariate Omitted	Pupping Period		Molting Period	
	Trend	% Change	Trend	% Change
None	9.22		2.08	
Date^2	9.66	+4.7	1.99	-4.3
Time to midday and time to midday^2	8.59	-6.9	2.49	+19.6
Precipitation			2.53	+21.3
Tidal stage	7.91	-14.1	1.96	-5.8
Count quality	10.68	+15.8	2.22	+6.3
Wind speed and wind speed^2			1.88	-10.0
All covariates omitted	5.47[a]	-40.7	0.70[b]	-66.3

[a] 95% Confidence Interval = (3.28, 7.70)
[b] 95% Confidence Interval = (-1.24, 2.68)

Table 3. Mean harbor seal counts (and % change from the maximum) for levels of categorical variables adjusted for other variables in the models.

Variable	Level	Mean Total Count (pupping period)	Mean Total Count (molting period)
Precipitation	none		199
	rain		178 (-10%)
Tide	falling	132	219
	low	132	215 (-2%)
	rising	126 (-4%)	193 (-12%)
	high	44 (-67%)	138 (-37%)
Count Quality	low	89 (-30%)	159 (-40%)
	moderate	86 (-33%)	160 (-39%)
	high	127	263

Figure 1. Location of harbor seal population monitoring sites at Nanvak Bay, Alaska.



POPULATION TREND

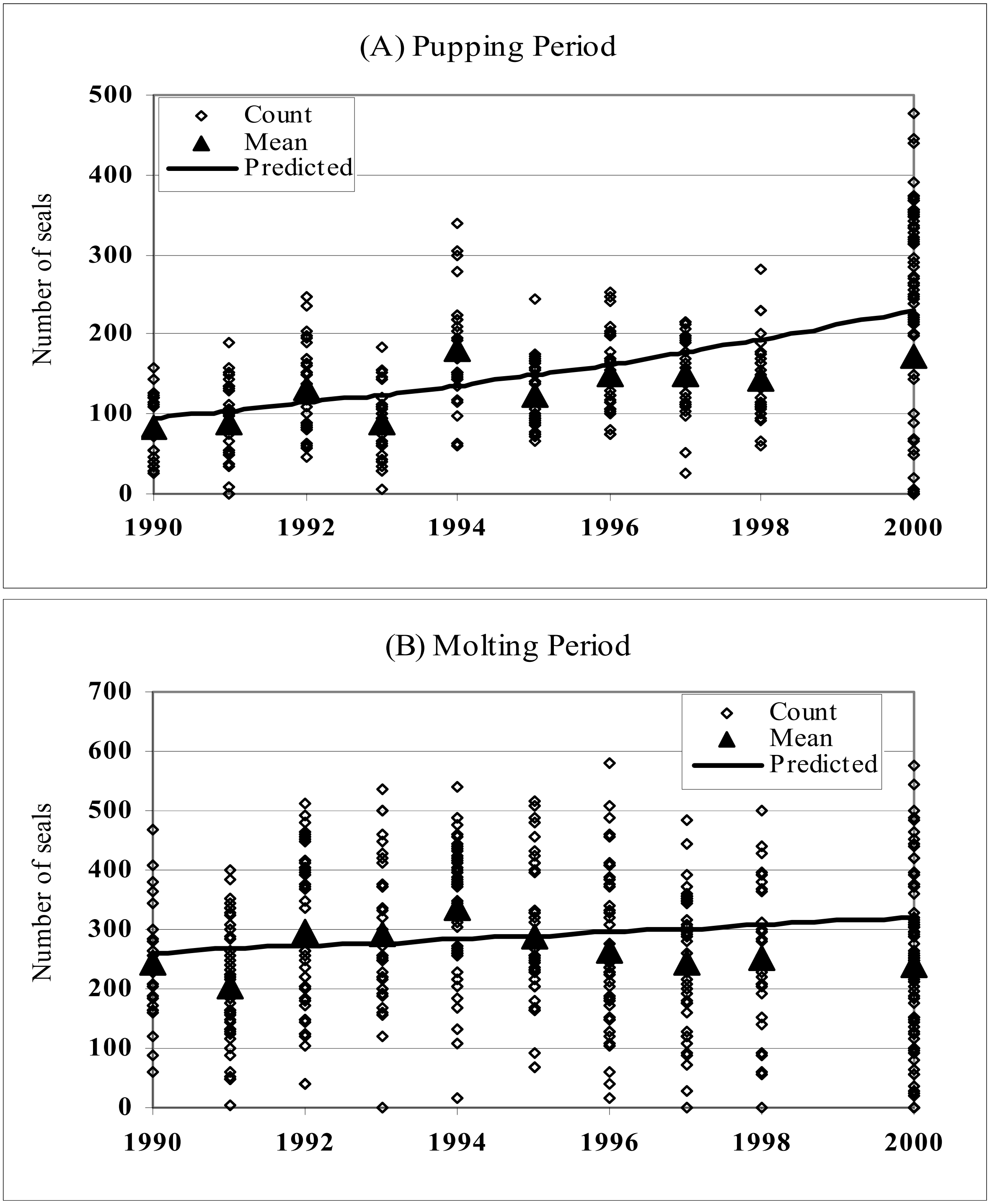


Figure 2. Estimated population trend (solid line) of harbor seals at Nanvak Bay, Alaska, 1990 – 2000, based on counts (open diamonds) of all seals during (A) the pupping period, and (B) the molting period. Solid triangles represent mean annual count. In later years, especially 2000, more counts were conducted early in the day (when counts are generally low), resulting in lower mean counts in those years.

COUNTS VS. TIME OF DAY

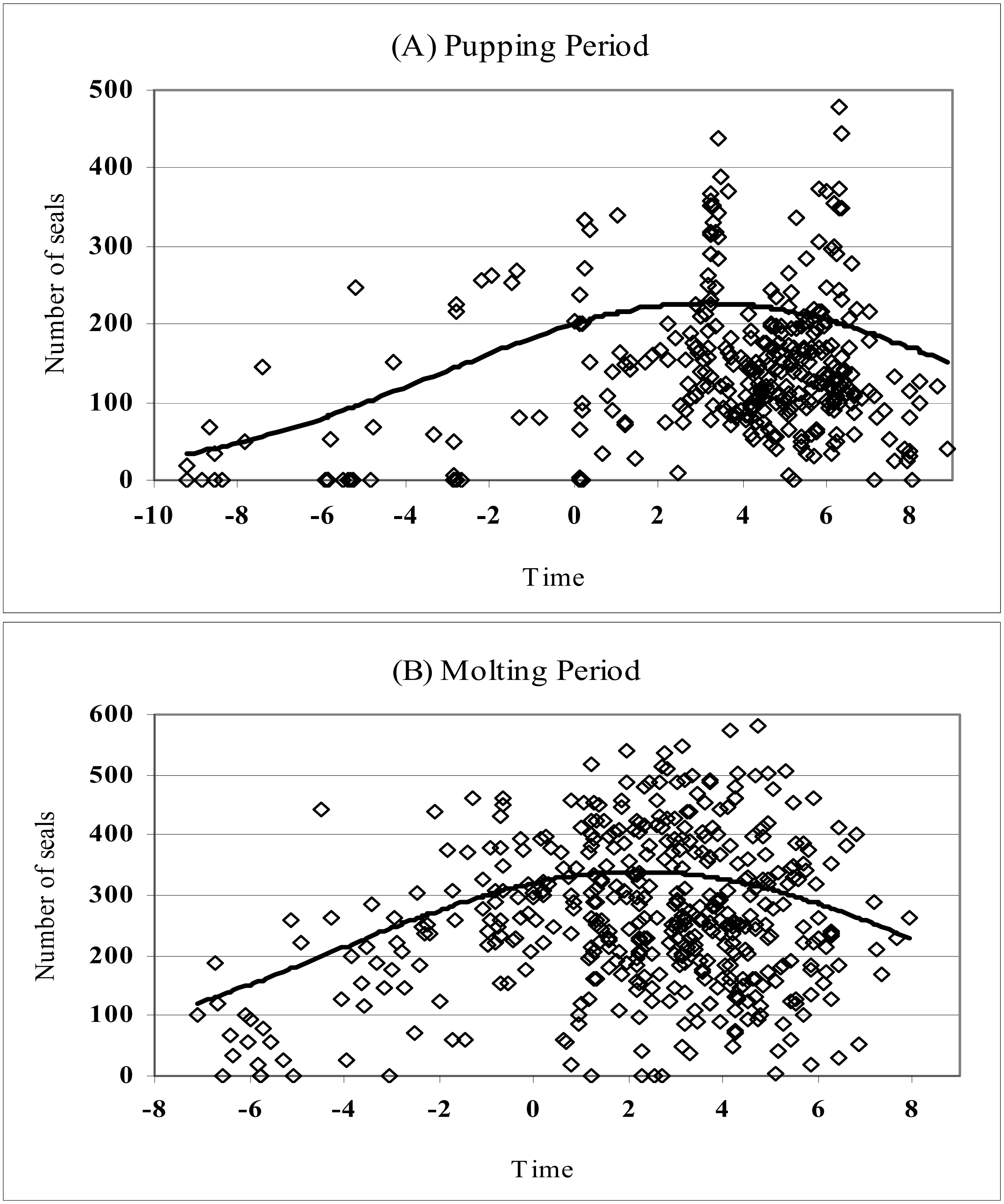


Figure 3. Predicted relationship (solid line) between time of day and counts (open diamonds) of harbor seals during (A) the pupping period, and (B) the molting period at Nanvak Bay, Alaska, 1990 – 2000. The x –axis represents time relative to midday (solar noon), which was 14:49 hrs on 25 June during pupping and 14:51 on 25 August during molting.

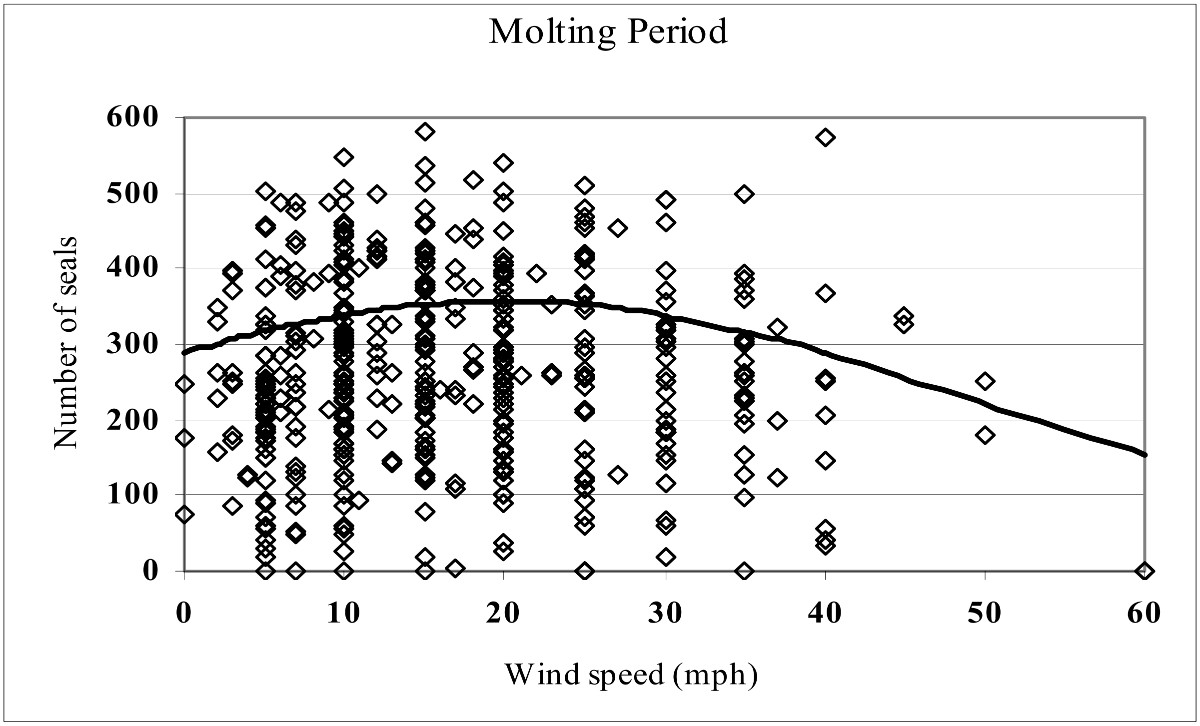


Figure 4. Predicted relationship (solid line) between wind speed and counts (open diamonds) of harbor seals during the molting period at Nanvak Bay, Alaska, 1990 – 2000.

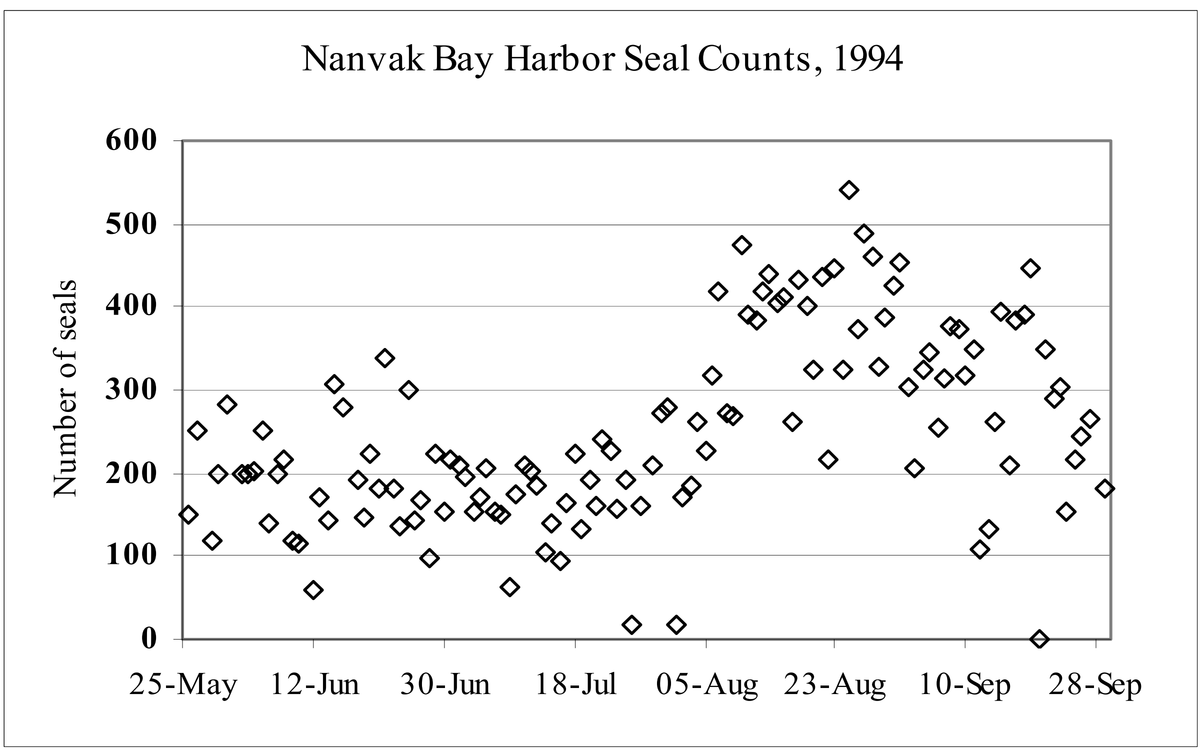


Figure 5. Counts of harbor seals at Nanvak Bay, Alaska, 1994.

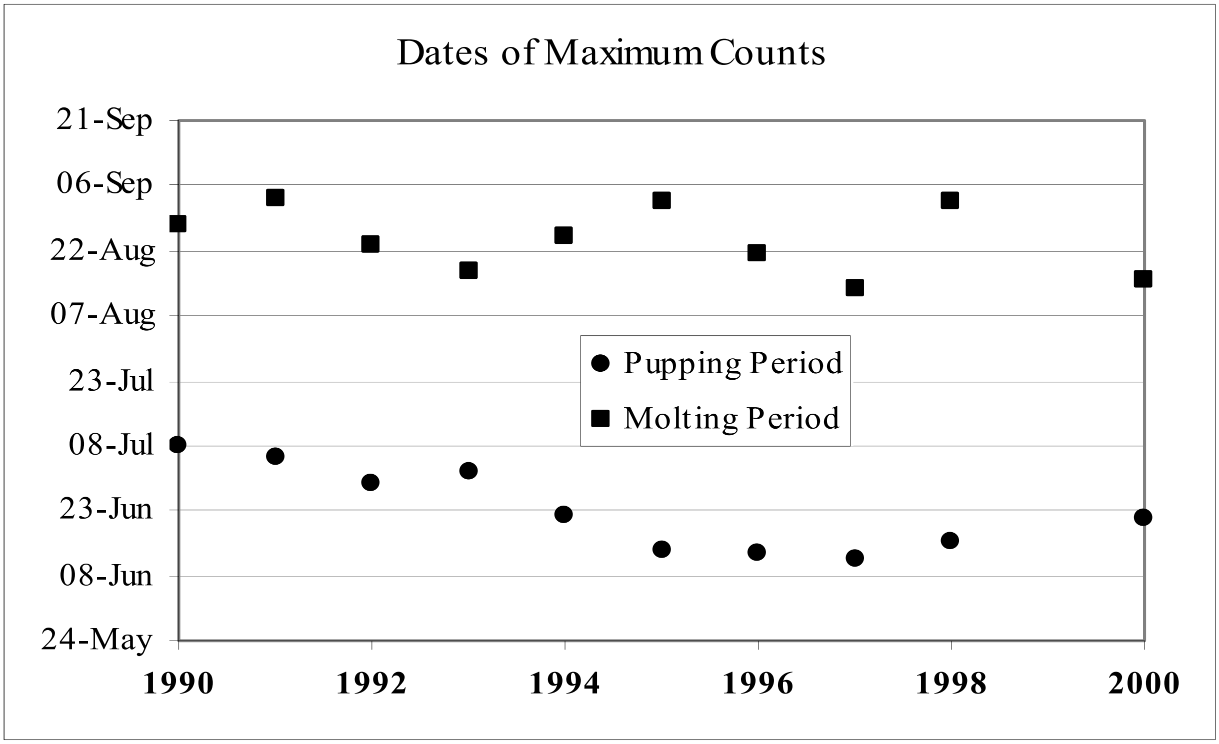


Figure 6. Date of annual maximum counts during pupping and molting periods at Nanvak Bay, Alaska. In 2000, counts during the pupping period did not begin until 20 June, later than usual; the maximum number hauled out could have occurred prior to that date.